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PRELIMINARY STUDY OF LAKE PONTCHARTRAIN AND VICINITY
USING REMOTELY SENSED DATA FROM THE ERTS-A SATELLITE

15 July 1973

Type I Progress Report

Contract: NAS5-21740

Principal Investigator: John U. Hidalgo UN605

Alfred E. Smalley

Kenneth H. Faller

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SAMPLING AND SENSING FROM SATELLITE

A thirty minute television
program in the WDSU, produced
Tulane University Information Series

by

John U. Hidalgo, Alfred E. Smalley, and Kenneth H. Faller

ABSTRACT

The Engineering Sciences Environmental Center at Tulane University has been involved in the interpretation of multispectral data acquired by the Earth Resources Technology Satellite. Computer analysis of digital tapes containing the satellite imagery covering the southeastern portion of Louisiana has provided useful information on seasonal variation of certain vegetation species, circulation patterns in Lake Pontchartrain and on urban neighborhood quality. The variation of swamp area covered by duckweeds (*Lemna minor* and *Spirodela oligorrhiza*) as determined by a linear classification scheme on data acquired on 7 August 1972, 12 September 1972, and 16 January 1973, is shown on classification maps of the area south of Pass Manchac, Louisiana. In the study of Lake Pontchartrain, excellent correlation between surface measurements and remote data has been achieved, with turbidty being the most important surface parameter in the correlation. Using a quadratic classification technique to distinguish urban neighborhood types, a map of the metropolitan area of New Orleans has been produced. This classification scheme uses all four spectral bands to classify each picture element as water, park, commercial, good quality residential, blighted residential, or severely blighted residential. Comparison with field observations shows good agreement.

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At this time, work has been completed on two of the four projects undertaken under this contract, a third is progressing well, while a fourth, the Cypress Tree Health Monitoring Project has been delayed by manpower limitations.

I. Monitoring of Spirodela Oligorrhiza and lemna minor (duckweeds)

The analysis of the digital tapes of 7 August 72, 12 September 72, and 16 January 73, has been successfully completed. The area south of Pass Manchac, the small strip of land separating Lake Pontchartrain from Lake Maurepas, was subjected to a classification scheme which designated each individual pixel as either duckweed-like, possibly duckweed-like, not duckweed, or water.

The scheme began with the recognition of a light lavendar characterizing duckweed both in the color composites of ERTS bands 4,5 and 7, and in low altitude color IR photography. Such areas--confirmed as duckweed covered by personal inspection--were designated as duckweed training sets. Areas covered with other vegetation were chosen as non-duckweed training sets, and water areas with no plant cover as water training sets.

Each set was then located in the MSS tapes and the average intensity in each of its bands computed. Three ranges of average intensities were thus established; duckweed, not duckweed, and possibly duckweed. In the case of exposed water, it was found that a very low intensity in band 7 was a sufficient discriminant.

To classify an unknown pixel, its intensity in each band was tested against the appropriate set of three ranges, unless band 7 had already identified it as water. If a given band fell within the duckweed range for that band, a score of two points was accumulated. If it fell in the intermediate range ("possibly duckweed") one point was accumulated. If the intensity fell in neither range, no points were given. A total score for the four bands of 6 to 8 classifies the pixel as duckweed, 3 to 5 as possibly duckweed, and 0 to 2 as not duckweed.

The results of so classifying the Pass Manchac area were presented in a computer printout using a distinctive character for each classification. In these printouts we observed a marked decrease in the duckweed-identified areas from August to September and a large increase in exposed water. Also

apparent is the decrease of other vegetation not specifically classified. This is expected, as is the decrease in water area covered with the duckweeds.

These two dates were classified by the same criteria, with results that compare satisfactorily with high and low altitude photography. However, preliminary examination of the January data found the intensities in each band for all types of test areas generally much less than the intensities previously recorded. A new examination of training sets was therefore made and a new set of values chosen for the criteria. The results were not as good as for August and September, with very large areas expected to be water classified as possibly duckweed. Until this time, the winter has been very mild, so this may in fact be the case, i.e., there may be a light coverage of the small plants; it is, however, still surprising.

One questionable classification that has not been resolved is the designation of the highway area as possibly infested with duckweed. There are indeed canals along the highway that show some coverage by the aquatic plants, but even given incomplete resolution of the canals and road, we would not expect the classification of the area as "possibly duckweed." This may then indicate a flaw in the classification algorithm, which was chosen for simplicity as a first exercise.

II. Observation of Cypress Trees

Dr. Smalley's visits to the selected study areas have shown that the problem of comparing cypress stands with each other is more complicated than had been anticipated. Where there has been significant defoliation, due to seasonal changes or to declining health, the surface under the trees in all observed cases where defoliation was significant was water, covered in some cases with duckweed (Lemna minor and Spirodela oligorrhiza) and in others with water hyacinth (Eichhornia Crassipes). This variation of undergrowth will have a marked effect on signatures obtained for the different areas, when in fact the cypress stands themselves may have identical foliage characteristics.

Because of this problem and the lack of manpower to resolve it, work on this project has been suspended. When higher priority tasks permit, we will define test areas with uniform undergrowth or try to develop an algorithm for correcting for undergrowth effects.

III. Delineation of Water Masses in the Three-Lake System

During this reporting period, significant progress has been made. Comparison with the underflight multiband photography has been thought-provoking, and excellent correlation with surface observations has been obtained.

A thirty-two level printout of the eastern Lake Pontchartrain-Lake Borgne area was produced from the bulk digital tapes. From this printout and the underflight photography, the location of surface measurement stations

was determined, and the intensities for the four MSS bands were extracted for an area within about a 2000 foot radius of the station. Similarly, film densities were extracted from the original negatives taken with the International Imaging Systems multiband camera coincident with the ERTS pass of 12 September 72.

The quality of the I^2S data has already been described in a previous report as disappointing. Problems with exposure, processing, and sun glitter complicated analysis of these data, and the results must be presented with less than full confidence. With this taken into consideration, the following table gives the correlation of the ERTS intensities with the I^2S original negative film densities.

ERTS MSS Band	I^2S BAND Blue .39 - .48μ	Green .46 - .61μ	Red .58 - .70μ	Infrared .73 - 95μ
4 .5-.6μ	0.927	0.775	0.820	0.332
5 .6-.7μ	0.753	0.640	0.672	0.571
6 .7-.8μ	0.057	0.024	0.028	0.930
7 .8-1.1μ	0.049	0.019	0.930	0.857

We cannot speculate just now on the explanation of this scrambling of the spectral data, but the problem may very well lie with the photography.

Excellent correlation of the MSS intensities was obtained with the surface measurements (chlorophyll, suspended solids, secchi transparency, depth, and temperature). Canonical correlation techniques were used to obtain linear combinations for the two sets of data (surface and remote) with maximum correlation. The best two such functions had canonical correlation coefficients of 0.9314 and 0.7511, with chance probabilities of 0.0000 and 0.0144 respectively. Loading analysis indicated that the important surface parameters in the correlation are secchi transparency, suspended solids, and temperature. These results are very encouraging, and indicate that the various factors which differentiate water masses within the lake system are detectible from the ERTS satellite.

The MSS data at the surface sampling stations indicates that there is a distinct variation of water color from one area to another. Northern Lake Borgne is slightly different in appearance from southern Lake Borgne, and distinctly different from northern Lake Pontchartrain, while the areas in the Intracoastal waterway (ICWW) and Mississippi River - Gulf Outlet (MR-GO) appear very similar to the area at the mouth of the Inner Harbor Navigation Canal, the point at which the ICWW and MR-GO empty into Lake Pontchartrain. We are currently considering the feasibility of applying a classification algorithm to the data to differentiate the various apparent water types. This work will continue into the next reporting period.

IV. Urban Neighborhood Analysis

The work performed during the current reporting period has been very satisfactory and all of the proposed work for this project has been completed. Twenty training sets were used to classify urban neighborhoods as park, commercial, good residential, blighted residential, and severely blighted residential. Comparison with a classification performed by the City Planning Commission shows good agreement.

Two sets of maps have been generated which include most of the metropolitan New Orleans area. The first is a set of six density slices for each of the four bands. The second was a single map of the urban area on which a distinctive symbol was printed for each of the above mentioned neighborhood classifications.

For the first set of maps, the cut points for each slice were determined from the binomial approximation to the normal distribution, using statistics taken from the urban portion of the metropolitan area. Band 7 of the MSS in particular delineated intense urban development, urban residential areas and the suburbs, as well as major transportation corridors.

The other map is a very detailed representation of the metropolitan area. A quadratic classification scheme was applied to the ratios of band 4 to band 7, band 5 to 6, and band 5 to 7, with the intensity in band 7 as the fourth orthogonal space. One-and-a-half standard deviations were used to define clusters around the averages for each of the neighborhood types except the commercial, where 1.65 standard deviations was used. If a point did not fall within any of these clusters, a linear test on bands 4 and 6 classified it as park, or left it unassigned.

The Regional Planning Commission, which performs a function similar to that performed by the City Planning Commission for the metropolitan New Orleans area, has expressed much interest in both the series of maps and has been provided copies for their analysis.

The only effort on this project during the next reporting period will be the final report.